

A brief history of the Bureau of engraving and printing with a description of its work.

United States.

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BUREAU OF ENGRAVING AND PAINTING WITH A DESCRIPTION OF ITS WORK



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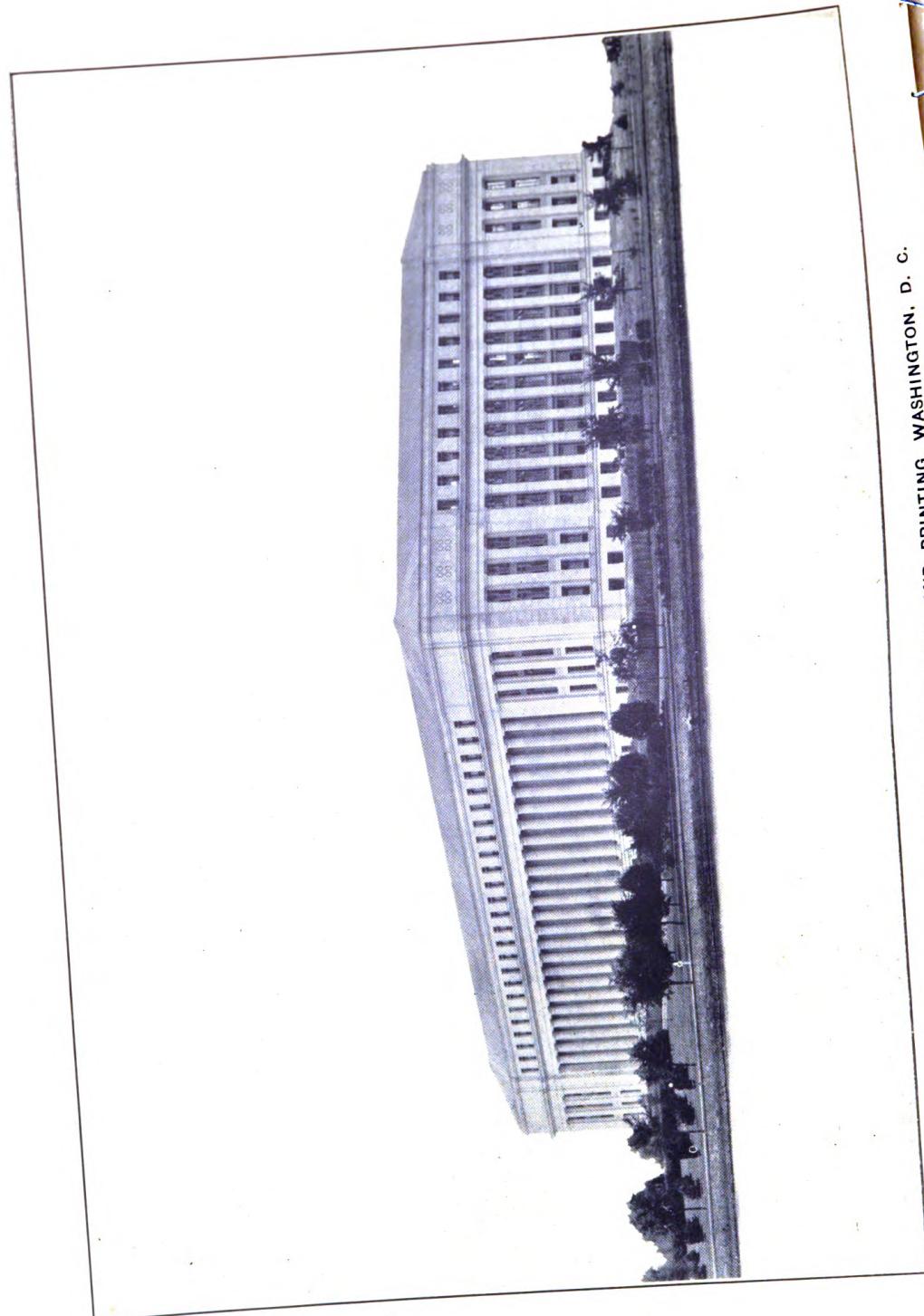
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A BRIEF HISTORY
OF THE
**BUREAU OF ENGRAVING
AND PRINTING**

WITH A DESCRIPTION
OF ITS WORK



UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1929



UNITED STATES BUREAU OF ENGRAVING AND PRINTING, WASHINGTON, D. C.

A BRIEF HISTORY
OF THE
U. S. BUREAU OF ENGRAVING
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A BRIEF HISTORY OF THE BUREAU OF ENGRAVING AND PRINTING

HISTORY OF PAPER CURRENCY IN THE UNITED STATES

Prior to the outbreak of the Revolutionary War, bills of credit and other forms of paper currency were put into circulation by private banks and by some of the Colonies. At the beginning and during the progress of the Revolutionary War paper money was issued by the Colonies and also by the Continental Congress. Some of this early currency was engraved. That issued by the Provincial Congress of Massachusetts in 1775 was engraved by Paul Revere, a hero of the Revolution. From that period until the commencement of the Civil War, State banks issued engraved paper currency.

The old demand notes issued in 1861 and 1862 were the first paper money issued by the present Government of the United States. These were followed by the issue in 1862 of United States notes, commonly known as "legal tenders," or "greenbacks." Other kinds of paper currency have since been authorized, and at the present time five kinds of paper currency are issued, namely, United States notes, silver certificates, gold certificates, national-bank notes, and Federal reserve notes.

ORIGIN OF THE BUREAU OF ENGRAVING AND PRINTING

At the time the first issue of "greenbacks" was authorized, private bank-note companies alone were equipped to engrave and print such securities, and consequently these legal-tender notes were engraved and printed under contract by these companies, and then forwarded to the Treasury Department for the signatures of the Register of the Treasury and the Treasurer of the United States and for the affixing of the seal, and for trimming and separating before being put into circulation. At first these signatures were inscribed by a corps of clerks and the notes were trimmed and separated with shears, but as the demand for the notes increased it was not only impossible for the workers to keep pace with the public requirements, but the system proved expensive and the many styles of penmanship in signatures increased the possibility of counterfeiting. To obviate this condition, permission was granted by Congress in March, 1862, to imprint the facsimile signatures on the notes in the Treasury Department from engraved plates. A little later machines, at first propelled by hand but later driven by steam, were constructed for trimming and separating the notes.

The trimming, sealing, signing, and separating of the notes by machinery proved successful, and it was determined that an effort should be made to perform all the mechanical operations, including engraving and printing, at the Treasury Department. Congress vested authority in the Secretary of the Treasury to have such

securities engraved and printed at the Treasury Department in Washington in case he deemed it inexpedient to procure such notes by contract, as set forth in section 2, act of July 11, 1862, as follows:

Sec. 2.—And be it further enacted, That the Secretary of the Treasury be, and is hereby, authorized in case he shall think it inexpedient to procure said notes, or any part thereof, to be engraved and printed by contract, to cause the said notes, or any part thereof, to be engraved, printed, and executed in such form as he shall prescribe, at the Treasury Department in Washington, and under his direction; and he is hereby empowered to purchase and provide all the machinery and materials, and to employ such persons and appoint such officers as may be necessary for this purpose.

About this time the various operations which had been performed in separate divisions of the Treasury Department were consolidated into one division known as the First Division of the National Currency Bureau, which was shortly thereafter changed to the Bureau of Engraving and Printing. This act of July 11, 1862, therefore, may be regarded as the organic act of the Bureau of Engraving and Printing as, prior to its passage, none of the public securities had been engraved or printed other than by private contract.

On August 29, 1862, the Chief of the Bureau of Engraving and Printing, with one male and four female assistants, commenced the trimming, sealing, signing, and separating, by machinery, of the one and two dollar notes. On November 20, 1862, with two engravers and one transcriber, the work of engraving the plates for the printing of securities was commenced. From this date, the work done by private companies was gradually absorbed by the Treasury Department, until all of the printing of the securities of the Government was done at the bureau, the last work to be taken over being that of postage stamps, which the bureau undertook in 1894.

GROWTH OF THE BUREAU OF ENGRAVING AND PRINTING

The Bureau of Engraving and Printing in 1862 occupied one room in the attic of the west wing of the Treasury Building. The work increased until, in 1878, no additional space was available for expansion. On June 30, 1878, Congress appropriated \$300,000 for the purchase of a site and the erection of a building at Fourteenth and B Streets SW. to house the engraving and printing of United States securities. This building was completed and occupied July 1, 1880. The volume of work continued to increase and in 1891 a wing was added to the southwest end of this building. In 1904 another wing was added to the west end and fireproof outbuildings were erected for the mechanical shops. In 1907 Congress, realizing that the building was entirely inadequate for the ever-increasing work of the bureau and the space too limited to allow further additions, appropriated funds for the cost of plans, estimates, and specifications for an entirely new building on another site. As a result the Bureau of Engraving and Printing, as it is to-day, at Fourteenth and C Streets SW., was completed and occupied early in the spring of 1914, at a cost of approximately \$3,000,000.

This building is of the modern type of factory building. It was designed with a view to facilitating the work and at the same time affording a maximum of comfort to the employees. Owing to the nature of the output, employees are not permitted to leave the build-

ing during the day, and therefore expense was not spared looking to the health and comfort of the employees. The rooms throughout the entire building are thoroughly ventilated, the system installed changing the air two or three times every hour; the windows are large, insuring a maximum amount of natural light and a minimum need for artificial light; a special refrigerating system was installed for producing cool water for drinking purposes, which is dispensed at fountains located throughout the building; the heating system is of the most modern type; a battery of modern elevators was provided both to handle the output and to transport the employees; and the main stairways are spacious and are designed to serve as fire escapes, in addition to the emergency stairs at the end of each wing. Every effort has been made to incorporate in this building every architectural and mechanical device that would have a tendency to improve the welfare of the employees and elevate the standard of hygienic conditions under which they are compelled to work. Labor-saving devices have been installed which have effected great economies for the Government through increased efficiency of the employees.

The Bureau of Engraving and Printing has grown since 1862 from a small bureau occupying one room in the attic of the Treasury Department Building and employing a handful of people, to a large modern factory 505 feet long, 296 feet deep, and 105 feet high, with four floors, basement, and attic. The building provides 442,000 square feet, or about 10 acres of floor space, and accommodates approximately 5,000 employees, of whom 55 per cent are women and 45 per cent men. Notwithstanding the great increase in size, this new building has been found inadequate for all of the work of the bureau, so that the engraving division with its 200 employees was returned to the old bureau building in October, 1925.

DESCRIPTION OF THE WORK

ENGRAVING

Engraving is one of the oldest of the arts. Before the fifteenth century wood engraving was an independent art. In about the middle of the fifteenth century steel engravings were introduced and increased in use rapidly thereafter. In the present period steel engravings are largely confined to securities, not only because it is possible to create works of art but because the characteristics of the engraver are reflected in his work, thus preventing their exact duplication by counterfeiters.

The most skilled engravers in their respective specialties to be found in the world have been employed by the Bureau of Engraving and Printing from its very beginning. The specimens of portraits, vignettes, and lettering exhibited by this bureau were awarded the highest premiums at the Vienna Exhibition in 1872, at the Centennial Exhibition in Philadelphia in 1876, at the Exposition in Paris in 1878, at the Columbian Exposition in Chicago in 1893, at the Paris Exposition in 1899, at the Louisiana Purchase Exposition in St. Louis in 1904, at Jamestown Exposition in 1907, at Alaska-Yukon Exposition in Seattle in 1909, at the Panama-Pacific Exposition in San Francisco in 1915, and at the Sesquicentennial Exposition in Philadelphia in 1926.

When it has been decided to issue a new note or other security the matter is discussed by the officials in charge of the several branches of the Government service involved, and the conclusions reached by them as to the character of the design are embodied in a model made by a trained designer in the engraving division, where every form of security has its origin. This model is submitted for the criticisms of the officials in charge and, when approved by them, is forwarded to the Secretary of the Treasury for final approval. The design is then reproduced in soft steel by men who have specialized in the various kinds of engraving, as portrait, vignette, ornamental, or letter. Each engraver, with a steel tool having a diamond-shaped point known as a graver and aided by a powerful magnifying glass, carefully carves his respective portion of the design into the steel, conscious that one false cut or slip of his tool or miscalculation of width or depth of line may destroy the artistic merit of his work and that weeks or months of labor will have been in vain. The original engraving, called a die, is then heated in cyanide of potassium and hardened by quickly dipping it into oil or brine. It is then placed on the bed of a transfer press and a cylinder of steel, called a roll, held fast by the levers of the press, is rolled over the die under great pressure until the soft steel of the roll is forced into the lines of the engraving, perfectly reproducing it in relief on the circumference of the roll. The work of each engraver contributing toward the particular design is thus transferred to rolls, which through this method of transfer are assembled on one roll. This roll is hardened in the same manner as is used for hardening dies. The design is then transferred from the roll to a steel plate by the same method as is used to transfer from the die to the roll, the impression from the hard roll with engraving in relief making an intaglio or cut-in impression on the plate. The engraved plate, when hardened and cleaned, is ready for the printer. It reveals the individual excellence and characteristics of a number of skilled engravers, making it difficult for a counterfeiter to make a perfect reproduction of this composite work of other engravers. A roll will duplicate an engraving a great many times before wearing out and the original engravings or dies are preserved for making new rolls.

Another method of making plates, known as the electrolytic process, has been inaugurated and developed in the bureau. Through this process the life of an original plate has been greatly lengthened. When an engraved plate has been completed in every detail it is subjected to a certain treatment and then placed in a special bath and by means of electrodeposition a plate is built thereon to a required thickness called an alto. The plate is removed from the bath and the alto separated from it. The engraving on the plate being intaglio, the engraving on the alto naturally is in relief, as has been stated in the case of a roll by the transfer process, except that the alto is a flat surface. The alto, in like manner, is placed in a bath. Nickel and copper are deposited on it. When separated the plates are in intaglio. The alto can be returned to the bath as often as may be desired for the making of additional plates.

These electrolytic plates consist of alternate layers of nickel and copper deposited electrochemically, over which is deposited a layer of chromium only two ten-thousandths of an inch in thickness, to

insure satisfactory wearing properties of the plate. Chromium is a rather rare metal, ranking next to the diamond in hardness. It is found in nature as chromite, usually in combination with iron, sometimes with lead and in small quantities in silicates. Chromium has found its principal commercial application in the manufacture of stainless steel.

Photolithography is used in the manufacture of zinc and high-etched plates for printing internal-revenue stamps, checks, and similar classes of work, and a complete section in this division is devoted to this undertaking.

All dies, rolls, plates, altos, negatives, etc., either finished or unfinished, are placed in the custody of the plate vault, a burglar and fire proof vault, and are issued only upon proper requisitions.

DISTINCTIVE PAPER

One of the earliest safeguards to the notes and securities of the Government, adopted during the Civil War, was the printing of them on a thoroughly distinctive paper, used only by the Government. As early as October 13, 1862, a contract was entered into by the Secretary of the Treasury, upon the recommendation of the first chief of the bureau, for the manufacture of a special kind of membrane paper to be used for the printing of United States notes. The manufacture of this paper was continued for some time, but was ultimately abandoned and a localized and distinctive fiber paper adopted. The first contract for manufacturing this paper was placed with a private manufacturer at Glen Mills, Pa. All the work was done under the direct supervision of an agent appointed by and responsible to the Secretary of the Treasury. This paper was used until June 30, 1879.

From June 30, 1879, to July 1, 1885, a silk-threaded paper was used. A distinctive paper finished on both sides and having a silk fiber imbedded in it was adopted in 1885 and its use was commenced in the following year and has been continued ever since. This paper now used is made in Massachusetts under the same supervision and protection of the Government.

Prior to July 1, 1881, the paper was purchased from appropriations of the Bureau of Engraving and Printing. By the act of March 3, 1881, Congress made a separate appropriation for the purchase of distinctive paper for the fiscal year ended June 30, 1882, and the same policy has been pursued each year since, placing both the purchase and custody of the distinctive paper under another division of the office of the Secretary of the Treasury.

INK MAKING

All ink used for intaglio printing and a great proportion of that used for surface printing is manufactured at the bureau by mixing dry colors, bases, oils, etc., in large kneading mixers, which resemble those seen in large bakeries for mixing dough. From these machines the ink is ground in mills between three heavy steel rollers under pressure so that the materials are well ground and amalgamated.

Barytes, the base for most plate inks, is derived from the mineral product, natural sulphate of barium. It is mined chiefly in Missouri, where it is put through special milling machinery, crushed and

ground to a fine powder, and floated out on water, a process which produces a smoothness and texture suitable for making ink. Barytes comprises about 30 per cent of the bulk of the ink used in the bureau.

The dry colors, which are purchased by the bureau, are made from coal-tar dyes, ground minerals, and chemical precipitations, more of the latter two being used on account of their permanency against light and atmospheric influence. These colors do not have as much of the brilliancy as characterizes those made from aniline, a base used in dyes obtained from coal tar, yet there is solidity and softness that is more artistic. The only aniline colors used are the reds and those colors which contain red (purples, browns, and oranges), and they are used largely in the printing of postage stamps. For yellow, chrome yellow is used, which is made artificially and is chemically chromate of lead; for blue, Prussian and ultramarine blues are used, the former being made from a great variety of substances and even electrolytically from the nitrogen of the air, while the latter is made by calcining synthetically the constituents of lapis-lazuli, a rich blue stone; and for black, bone black is used, which is practically carbon made from calcined bones, mineral blacks obtained from earth deposits, and such blacks as retort residues found in various industries such as the manufacture of gas, etc. The green pigment, which is very familiar to all Americans as the color used in printing the green backs on our money, is a mixture of blue and yellow. All of these are inorganic except Prussian blue, which is partly organic and partly inorganic.

The outstanding difference between the plate-printing inks and those used in the surface work is in the fineness of the grinding, the former being a coarser-grained product that can be easily wiped from the plates, while the latter is ground extremely fine so that it will distribute evenly on the many fast-revolving rollers used on a typographic press.

After the ink has been manufactured and tested, it is packed in large buckets and delivered to the several divisions requisitioning it, and issued to the printers as needed. Any ink collected as "waste ink" at the close of the day is returned to the ink-making division and reconditioned for further use.

WETTING PROCESS

The distinctive paper used in printing Government securities is forwarded from the manufacturer to the division of paper custody of the Treasury Department, and is drawn by the wetting division of the Bureau of Engraving and Printing upon requisition, as required. The paper is received in sealed packages of 1,000 sheets each and after the packages are counted to verify the number of thousands received, the seal is broken, and the paper weighed and hauled to operatives who count the sheets in each package to determine if they contain the 1,000 sheets. These employees signify to the correctness of the packages by signing their names to tags placed in the packages.

Moist paper is more pliable and the engravings can be printed under less pressure and with a clearer impression than on dry paper. The wetting of the paper is done by machines equipped with a felt blanket on which the sheets are automatically fed, one at a time, under a spray of water. They are carried forward by the machine

and pass between two rubber rollers, at which point adjustments are made to regulate the amount of moisture being distributed over the sheets. When the wet sheets reach the delivery end of the machine, they are automatically packed in a box from which they are removed by operatives, shaken up into even packages, and counted in lots of 100 sheets each. These packages are then removed, weighed, stacked on movable platforms, and hauled to the stockroom of the wetting division. Here they are wrapped with moist cloths and weighted with heavy iron weights, and allowed to stand for three or four days to permit the moisture to be properly distributed to every fiber of the sheets. While the paper is being thus prepared for the plate-printing process, it is constantly under supervision of experienced workers, who must exercise both care and good judgment, as improperly wet paper would cause a great amount of trouble in printing.

During the winter season, on certain classes of work, the low temperature of the water will not permit the moisture to penetrate the fibers of the paper as satisfactorily as it should, and in order to overcome this the machines are equipped with warm water, permitting the regulation of the temperature from 38° to 60°, thus rendering the wetting of these special jobs more nearly uniform.

Through each step of the wetting process the packages of paper are tagged by the person handling them, showing the contents of each package, the class and denomination of work for which intended, as well as the name of the individual, so that should any error be detected the offender can be traced and the error rectified.

The wetting division maintains a branch in each plate-printing section, and when paper is sufficiently seasoned for printing it is delivered from the main stockroom to the various branches for distribution to the plate printers as they require it. A printer's assistant when drawing paper for the day's work will present a draw slip to the representative of the wetting division in that section, giving the amount, class, and denomination of paper required. When she receives the paper she counts it at the press, and if found to be correct, packs it for the day's work and the printer gives the wetting division representative a receipt for the amount received. Should an error be found in the amount by the assistant, the paper is returned to the representative and the error is rectified before the printing is commenced.

The above-described process of wetting paper applies to the blank paper prepared for the backs of the notes, which are printed first. After the backs are printed on the sheets and the ink and paper dried, and the impressions examined in the examining division for the purpose of discarding any imperfectly printed sheets, the paper with perfect backs is returned to the wetting division, where it passes through the same process of wetting and storing preparatory to delivery to the plate-printing division for the printing of the faces of the notes on the reverse side.

Before 1911 all the paper used for plate-printing money was wet by hand. Small sections of paper were placed between wet cloths for a certain number of hours, after which the center or dry sheets were reversed and made the outer sheets, so as to place them in direct contact with the wet cloths for another given number of hours. The paper was then stacked and covered with moist cloths.

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In 1911 the first machine for wetting paper was installed and several years later an automatic feeder was placed on the machine. There are now 28 such automatic machines in use, capable of wetting approximately 1,000,000 sheets a day.

PLATE PRINTING

The plate having been engraved, the ink having been manufactured, and the paper having been prepared by wetting, the skill of the engraver is now reproduced on the paper by a most beautiful process of printing, that of printing from intaglio or engraved plates. It is a process that affords the maximum of security against counterfeiting.

Flat-bed power plate-printing presses, by means of which practically all of the money and bonds are printed, have been in use in the bureau since January 31, 1878. Prior to that date hand-roller plate-printing presses were used exclusively. From January 31, 1878, to June 30, 1889, steam-power plate-printing presses were used to print certain revenue stamps and backs of silver certificates, under lease from the owners of the presses requiring the payment of a royalty. By act of March 2, 1889, this royalty was reduced and the owners of the presses were required to keep the presses in repair, with the result that profitable operation by the owners could not be continued.

At the beginning of the fiscal year 1890 the power plate-printing presses were replaced by hand-roller presses. This method of printing, however, was not adequate to meet the demands made on the bureau and it became necessary in 1891 to print certain revenue stamps on surface printing presses from steel plates engraved in relief. In 1894 the bureau was awarded the contract for printing postage stamps for the Post Office Department and power plate-printing presses were installed to print these stamps. The printing of some internal-revenue stamps and the backs of notes by this method followed, but the act of July 1, 1898, requiring that "all bonds, notes, and checks shall be printed from hand-roller presses" abolished the power presses for the printing of the backs of notes, and the act of March 3, 1899, abolished them for the printing of such revenue stamps as had been printed thereon. This latter act, however, was repealed by act of March 4, 1907, and the printing of internal-revenue stamps was returned to power presses. On August 24, 1912, an act was passed authorizing the gradual installation of power presses for the printing of the backs of paper money and bonds, and by the end of the fiscal year 1917 all backs were being printed by this process. Up to 1917 the printing of faces of notes on power presses had not been attempted, but the urgent demand made on the bureau during the World War period resulted in Congress authorizing the Secretary of the Treasury, by act of October 6, 1917, to print during the continuance of the war all securities of the United States by any suitable process and on any style of press which he considered advisable. Under this authority, for the first time in the history of the bureau, both backs and faces of currency were plate printed on power presses, the first money face printed being that of a \$1 silver certificate on October 10, 1917. By the act of July 11, 1919, this authority was extended beyond the duration of the war and at the present time all the United States currency is printed in this manner except the faces

of national-bank notes which are printed on hand-roller motor-driven plate-printing presses for the reason that orders for these notes are often so small that it would be impracticable to make the four plates needed on the power press.

A flat-bed power plate-printing press is operated by one printer and two assistants. Each press is equipped with four engraved plates, securely clamped to movable planks. Four plates are used to a press in order that the operations of inking the plates, wiping off the ink, polishing the plate by the printer, and taking the printed impression from the plate by an assistant may be done simultaneously.

When the press is put in motion by the printer, each plate in turn passes under a rubber roller constantly turning against another roller revolving in an ink fountain, and the ink in this way is transferred to the plate and pressed into the delicate lines of engraving. The plate then passes under an oscillating device which is part of the press, and commonly referred to as a "wiper." The face of the wiper is equipped with a flat bed over which an absorbent paper or cotton cloth is automatically fed. The wiper is adjusted so that the paper or cloth passes lightly over the plate. The greater portion of the ink is removed from the face of the plate by this wiper, leaving only the ink in the lines of the engraving and a thin scum over the entire face. This scum is removed from the engraved plate by the plate printer, who polishes it with his bare hands. The four plates, thus polished, pass on to the assistant in turn who sits at the front of the press ready to register accurately on the plates the sheets of paper, which she has obtained from the wetting division representatives, as previously explained. The plates, as they leave the assistant, then pass under what is known as the impresion roller which transfers the design on the engraved plate to the sheet of paper. As each plate comes from this roller the other assistant carefully lifts the sheet off, examines it for imperfections in the printing, and places it, printed side down, on a tissue. The next sheet she places printed side up and a tissue on top, alternating all the printed sheets in this manner to prevent offsetting of the ink, which is still wet. The assistant taking the sheets off notifies the printer when his work is below standard, as he is responsible for the quality of work he turns out. He must so adjust the press and so polish the plates that the printed sheets produced will be of the high degree of excellence required in the currency.

As the sheets are printed throughout the day they are collected in lots of 200 by a messenger and delivered to counters of the examining division who are stationed in the several printing sections to count the wet work as it comes from the press. When the day's work is completed the printer carefully cleans all ink from his plates, which are then securely locked under heavy steel covers on the press. His assistant prepares a pass showing the amount of paper drawn from the wetting division, the class and denomination, the amount returned at the close of the day, in the event that the printer was not able to print the entire amount, and the amount printed, as well as the names of the printer and his two assistants. These

passes are then checked with the records of the wetting division, from which the paper was issued, with the records of the examining division to which the printed work was delivered during the day for counting, and by the custodian of presses, who is in charge of the automatic registers on the presses which record each impression as it is made. All of these records must be in agreement before the employees are permitted to leave the building.

DRYING, EXAMINING, SIZING, PLATERING, AND TRIMMING

As the freshly printed sheets are counted during the day, a record is made by a clerk of the examining division, known as an entry clerk, showing the class of work, denomination, series, plate numbers, name of printer, date of printing, etc., and such records are kept through the various stages of the examination of the notes, so that at any time the work may be identified.

In order that the sheets and the ink thereon may be thoroughly dried they are transferred to specially heated rooms known as "dry boxes," in which they are spread upon racks and allowed to remain during the night to dry. The next morning this work is collected, each printer's work being kept in separate piles, and delivered to the "tissue room." Here the tissues, which were inserted between every two sheets by the printers' assistants to prevent offsetting, are removed and the money and tissues are stacked in separate piles, the money being delivered to the examiners, who examine and count the printed sheets for imperfections. All perfect work is made up into packages of 1,000 sheets with paper "straps" indicating the hundreds. The imperfect work is separated from it. A record is made of each printer's work which the examiner examines and counts, setting forth the amount perfect and the amount imperfect. A great portion of the work discarded as imperfect because of smears, light breaks in the printing, or other defects is very often salvaged by workers who have been trained to touch up small breaks and clean off smears so that they can not be detected. Work that is imperfect beyond restoration is finally destroyed by maceration. The perfect sheets are delivered to vaults where, in the case of those with backs only printed, they remain safely guarded until requisitioned by the wetting division for preparation for the printing of the faces; and in the case of those with backs and faces both printed, they remain stored until they are thoroughly seasoned and ready for the next process, namely, sizing.

The sheets are then delivered from the vault to the sizing room, where they are automatically fed through a machine which coats each sheet with a mixture composed of glue, water, and a small quantity of alum. The sheets pass through this mixture and under a rubber roller which forces out excessive moisture before they are carried through a heated box on the machine to become thoroughly dry. At the other end of the machine an operative receives the sheets. They are arranged and packed in even piles and counted and checked again with the records before being returned to the vault at the end of the day. This sizing process not only gives a better finish to the currency but it strengthens the paper, making it more resistant to dirt, grease, and wear, and thereby lengthens the life of the note.

The next time the sheets of currency are removed from the vault they are passed through what is known as the "plastering" operation. Here each sheet is placed between two heavy cardboards. Seventy cardboards and 69 sheets with a thin steel plate at the top, at the bottom, and in the center make up what is known as a "form." These forms are run through a plaster press under 5,000 pounds pressure to the square inch. The form is removed, the sheets of notes are separated from the cardboards, counted, and checked with the records, and placed in the vault to remain until they are ready for delivery for the trimming operation. This pressing process has restored to the notes the smoothness which they lost in the printing and drying processes.

The sheets are now ready for the trimming operation, which is performed on machines which trim the margins on all four sides to the proper width, the margins having been a little wider than are required on the finished notes. The sheets are gathered from boxes in which they are delivered as they pass through the trimming machines, counted, checked with the records, and returned to the vault in packages of 1,000 sheets each. This is the final operation in the examining division and the notes are stored in the vaults until they are needed in the numbering, sealing, separating, and packing processes which follow.

NUMBERING, SEALING, SEPARATING, AND PACKING

The numbering, sealing, separating, and packing for delivery of all United States notes, certificates, and Federal reserve notes are performed in one division designated the numbering division. Because the money handled in this division is negotiable extra safeguards are thrown around it. All the work is performed within wire cages and a guard is stationed at the entrance to the division to see that no employee leaves or no employee from another division enters the division without special permission.

The packages of securities when received in this division are checked with schedules showing the amount, class, and denomination of the notes, and the sheets in the packages are counted to verify the amount in each before the work is delivered to the presses for completion. These presses are specially designed machines. Mechanical feeders feed the sheets automatically into the presses. The presses print numbers and seals on the face of the note, cut each sheet into the required number of notes, and count and collate the notes into packages of 100 each. These notes are then carefully examined, counted, and put up into packages by a corps of expert examiners and counters. To guard against error or duplication of numbers, which might lead to uncertainty as to the genuineness of the notes when in circulation, these examiners carefully examine each number to determine its correctness. The packages are secured with steel bands welded on each package by electric welding machines, wrapped in heavy wrapping paper securely fastened with Government paper seals, and packed in numerical order in metal trucks ready for delivery as required. A careful check is made at the end of the day to account for each note and package handled.

Every package that leaves the bureau bears a label giving the name of the examiner, date, class of work, etc., and in the event of a shortage being claimed after the notes leave the bureau, it can be traced to the person or persons responsible. Shortages, however, are seldom claimed, and these rarely if ever are proven to be actual losses.

BONDS, NOTES, AND CERTIFICATES OF INDEBTEDNESS

An important part of the bureau's work is the production of bonds, notes, and certificates of indebtedness, the approximate annual output since the completion of the World War issues being 2,000,000 sheets with a face value of \$8,000,000,000. Included in these are Liberty, postal savings, Panama Canal, pre-war, Treasury, Porto Rican, Philippine, and Federal farm loan bonds, Treasury notes, certificates of indebtedness, interim certificates, and debentures for Federal intermediate credit banks. The faces and backs are plate printed, which process is described on pages 8 and 9 of this booklet. The numbering, sealing, tinting, and overprinting of interest rates, due date, and of other matter is performed by surface printing, which is described on pages 15, 16, and 17. During and immediately following the World War the printing of Liberty bonds and Victory notes, both temporary and permanent, was a tremendous task, taxing the facilities of the bureau to the utmost. This task was completed by April, 1921. The total issues to that date were 191,344,560 bonds and notes of both temporary and permanent forms, with a face value of \$61,006,900,000.

POSTAGE STAMPS

The Bureau of Engraving and Printing also manufactures all the United States ordinary postage, postage due, special delivery, air mail, special handling, commemorative, and Philippine postage stamps, which are required to supply the 56,000 post offices throughout the United States, the Philippine Islands, Hawaii, Virgin Islands, Alaska, and the Canal Zone. Although the space allowed on the postage stamp for the development of artistic designs is considerably smaller than on the currency, yet the same care and skill are used in selecting the design and executing it in steel. There is a different design and color for nearly every denomination of postage stamp in each class.

New designs for stamps originate in the bureau at the request of the Post Office Department, and when approved by that department such designs are executed in steel by the same processes as are used in making steel plates from which currency and bonds are printed. Nearly all of the stamps, however, are printed on what are known as intaglio web presses, which presses require two curved plates. This curving is accomplished by a specially designed bending machine, after the plates are finished, which machine curves the plates to fit the cylinders of the presses. When the intaglio web presses were first designed it was for the purpose of supplying the Post Office Department with stamps in coils, used in stamp-vending and stamp-affixing machines. This method of manufacture proved so successful that it was extended to stamps delivered in sheet and book form, until

at the present time practically all denominations of ordinary stamps and the 10-cent special-delivery stamps are printed on these presses. Such stamps as are required, other than those printed by the rotary-press process, are printed on flat-bed power presses in identically the same manner as the currency and other securities.

INTAGLIO WEB PRINTING

Rotary printing is the term applied to the operation of printing on intaglio web presses, which presses are probably the most unique pieces of machinery ever devised for work of this sort. In a continuous operation this press wets the paper, inks and wipes the plate, prints the impression, dries the printed product, applies the gum, dries the gum, and winds the finished product into a roll. There is also attached to this press a device which will precancel stamps when desired. The roll paper as received is placed in the press and as the press is put in motion the roll unwinds, the paper first passing through two rubber rollers revolving in small tanks of warm water, where it is wet, and then passed through two other rollers which evenly distribute the moisture as they press out any in excess of the required amount. The paper then passes over curved engraved plates, two of which are clamped on and cover the cylinder of the press. These plates have been inked and wiped by the mechanism of the press, and as the paper passes against the face of the revolving plate the impression is made on the paper. The roll continues to unwind, as the printed portion passes on, over an electrically heated chute, which dries the paper and ink before the gum is applied. The gum is then evenly distributed over the back of the printed paper by means of a roller revolving in a gum hopper and the paper continues on through a heated chamber to the far end of the press, where it emerges from this "dry box," printed, gummed, and dried, and is again wound into a roll.

Although this press performs mechanical operations formerly achieved by a printer and his two assistants and two gumming-machine operatives, it still requires the services of a skilled plate printer with one male helper to operate the press and accurately adjust it at every point so that the finished product will be up to the high standard required for the bureau's output. Each of these presses has a daily capacity of from 1,800,000 to 3,000,000 stamps, depending upon the size of the plate, the size differing for each class of work—namely, stamps to be delivered in sheet form, coil form, or in book form. Those for delivery in sheet form are printed from 400-subject plates, 800 stamps being printed with each revolution of the cylinder; those for coils from 150 to 170 subject plates, 300 stamps and 340 stamps with each revolution, respectively, and those for books from 360-subject plates, 720 stamps with each revolution.

The paper used in the manufacture of postage stamps is made of bleached chemical wood fiber, derived from pine trees. This paper has no silk fibers imbedded in it, as the money paper has, nor is it watermarked. The gum used in the manufacture of postage stamps is made in the bureau, and consists of 58 per cent dextrine, 38 per cent water, and 4 per cent glucose.

FINISHING POSTAGE STAMPS

The stamps from the intaglio web presses are now ready for the final operations. The rolls printed from plates containing 400 stamps each are placed in specially constructed rotary perforating machines which, in one operation, perforate between the stamps in both directions and reduce the roll to sheets containing 400 stamps each as printed from the plate. During the perforating of the rolls the working margin on the sheet is trimmed to a standard of seven-sixteenths of an inch in width. These sheets are then examined and counted and put up in units of 100 sheets each. In designing the plates for 400-subject work, provision was made for separating the printed sheet in quarters; that is, a blank space five-sixteenths of an inch in width passing through the center of the sheet in both directions divides the sheet in quarters. Top and bottom cardboards are placed on these 100-sheet 400-subject packages, and they are stitched with wire staples through the blank margin of the sheets. These wire staples are so placed as to appear in the center of the margin of the sheet when reduced to the quarter sheet size. The stitched units of 100 sheets are then cut into quarters through the blank spaces that pass through the center of the sheets in both directions, the resulting packages being wire stitched and each containing 100 sheets of 100 stamps each. These packages are then incased in paper bands, initialed by the bander, dated, and sealed with paper seals ready for storage in the postage-stamp vault until requisitioned by the Post Office Department. The processes involved in reducing rolls printed from plates containing 200 subjects (special delivery) are identical with those applied to 400-subject work.

Everyone is familiar with the handy little stamp books, which can be purchased at all post offices, containing a varying number of sheets 2 stamps wide and 3 stamps deep, interleaved with paraffin paper. These books comprise twelve 2-cent stamps, twenty-four 2-cent stamps, and forty-eight 2 cent stamps; twenty-four 1-cent stamps, and ninety-six 1-cent stamps; and a combination of twenty-four 1-cent stamps and twenty-four 2-cent stamps. The books are made from the rolls of stamps printed from plates, containing 360 stamps each, 20 stamps wide by 18 stamps deep. These rolls are placed in perforating machines, as in the case of the 400-subject rolls and in one operation the roll is perforated in both directions and cut into sheets containing 360 stamps, the lengthwise perforations occurring only between every other row, the skipped space being left to allow for the cutting into the small books. The design of the plate used in the printing of book stamps allows for a stitching margin at the top of each three rows of stamps. Thus, when a sheet is printed from a book-stamp plate, each three rows of stamps is separated by a blank space five-sixteenths of an inch wide, marking off the sheet into six strips, each 20 stamps across and 3 stamps deep. The large sheets of 360 stamps are cut in half on cutting machines, each half containing three of these sections or strips. These half sheets, 180 stamps, are put up in packages according to the number of stamps to be in the finished books with cardboard on the top and bottom and paraffin sheets between the sheets of stamps. During this packing any imperfect sheets detected are discarded. These packages are then cut into strips through the margins referred

to and glued along the edges. A final examination and count is made of the stamps in this form and books found to be defective are marked and discarded when the strip is cut into books. After the examination and count the strips are stitched, two wire staples passing through the top and bottom covers securing the stamps within. The stitched strips are counted into units of 100 strips each and cut into individual books on cutting machines. The books are then counted into units of 10 each, sealed in a paper band, stamped with the operator's name, and placed in cardboard containers. Six banded units are placed in each box, which is sealed at both ends and in the center of the top of the flap of the box, and in this form the books are delivered to the Post Office Department as ordered.

Coils of stamps are made from rolls printed from plates containing 150 to 170 stamps. These rolls are considerably smaller than the other rolls, as they contain but 10 stamps across, whereas the other rolls contain 20 stamps. They are placed in special perforating machines which perforate the rolls crosswise only and wind them again into a roll. These perforated rolls are delivered to operatives at specially devised measuring tables, who unwind the rolls, measure them off into lengths of 500, 1,000, or 3,000 stamps, according to the number of stamps to be in the finished coil, cut off each length, insert labels denoting class and denomination of coil, by pasting one edge to the margin of the cut-off length and the opposite edge to the margin of the portion yet to be measured, thus joining the measured lengths with these labels. These lengths are rewound into rolls and the stamps are then ready for the next operation, that of coiling. The spindle on which the stamps were wound during the preceding operation fits into the coiling machine. Eleven knives on the machine slit apart the 10 rows of stamps and trim the margins of the outside rows as the rolls are unwound, and simultaneously each row is wound into coil form until the labels previously pasted on are reached. The operator at this point stops the machine, separates each coil from the roll by cutting at the label, pastes the label as a binder for each coil, and places her initials or name on the binder. The coils are then carried to tables, counted, and boxed ready for delivery to the vault from which they are shipped when ordered.

Finished postage stamps are stored in vaults subject to requisition from the Post Office Department. Postage stamps are packed for shipment, so far as practicable, in uniform size packages, e. g., coils are wrapped and packed 200 to the package, books 2,160 to the package, and ordinary stamps 200,000 to the package. Packages prepared for shipment are labeled with registered mail labels, and shipped direct to the different post offices throughout the United States and its possessions.

SURFACE PRINTING

With the exception of national currency and postage stamps, practically all other kinds of securities are printed either by the typographic or the offset processes. This work is performed in a division known as the surface-printing division, the functions of which are to overprint all national-bank currency, bonds, certifi-

cates of indebtedness, and other Government securities; to print and overprint, in their entirety, treasurer's checks, requests for transportation, physicians' prescription banks, bottled distilled spirits stamps, naturalization certificates, order forms for opium, licenses of various kinds, etc.; to print all classes of revenue stamps and to prepare for shipment and delivery all securities referred to above. This division is equipped with the latest improved types of flat-bed cylinder, rotary, and offset printing presses and bindery machinery similar to the equipment which will be found in any commercial printing establishment.

The numbering and sealing of national-bank currency is accomplished in this division instead of the numbering division, as is the case with respect to all other classes of currency. The sheets of notes are received from the examining division, counted, and recorded in the same way as other currency, but on account of the large number of small orders received from the numerous national banks for this currency, which necessitates frequent changes of the form in respect to serial and charter numbers, each bank having its own distinctive notes, and because the notes are delivered to the banks in sheets (four notes to a sheet), it is not feasible to have them finished on the same type of presses as other notes which are overprinted in enormous quantities without changing the form. National-bank currency is finished on automatic typographic presses which number and seal the notes in one operation.

Philippine pesos are overprinted with the seal and number on rotary presses, but instead of delivering in sheets, they are separated and delivered as single notes.

Overprinting of the interest rates, the due date, value, department, number, and seal on the various forms of Government securities, such as standard Treasury bonds, Federal farm-loan bonds, joint-stock land-bank bonds, certificates of indebtedness, Government checks, requests for transportation, bottled distilled spirits stamps, physicians' prescription blanks, permits to purchase liquor, naturalization certificates, order forms for opium, and various other classes of work are accomplished on flat-bed cylinder presses from type or electrotype forms. To accommodate this work a stock of 80,000 electrotypes and 3,170 numbering machines is maintained.

Internal-revenue stamps and all other classes of work in this division, other than currency and certain other securities, are printed on offset presses. Offset presses are of the rotary type and have proved to be very valuable to this bureau in producing large quantities of work. They are equipped to take large-size zinc plates upon which the subjects to be printed are photographed or etched, printing as many as 400 subjects at one time. The zinc plates upon which the subject is photographed are known as planograph plates, and the zinc plates upon which the subject is etched are known as dry offset plates. The dry offset plates have been developed to a very high degree of efficiency. The offset process, unlike plate printing with wet paper, prints an impression from the plates upon a dry rubber blanket, which transfers the impression to the dry paper.

All of the work printed in this division, except national-bank currency and some classes of internal-revenue stamps, passes through the bindery section for additional operations. The operations in

this section include examining, cutting, perforating, stitching, packing, trimming, and other bindery operations. The work is prepared and packed for delivery in units as required by the order.

Each printed impression from the presses in this division, including offset presses, flat-bed cylinder, and rotary presses, is recorded on the press registers and is hand counted and checked after each operation. The number of sheets issued to a pressman or other employee must be accounted for at the close of the day's work. Every printed sheet of paper must be counted, checked, and placed in the vaults at the close of each workday.

The greatest care has to be exercised in the printing, overprinting, and numbering of Government securities, regardless of class or denomination, in order to prevent duplication and other errors, as such errors might lead to uncertainty as to genuineness of securities in circulation. To avoid this there is, in addition to the skilled pressmen in charge of the printing presses, who use great care in handling the numbering devices, a highly trained force of skilled security examiners and other employees who carefully examine the printed impressions, numbers, etc., for imperfections and inaccuracies.

ACCOUNTING

Every possible safeguard is employed to protect the securities during the process of manufacture, and numerous checks are used to record their progress and to fix responsibility in the event of a shortage. After each operation the securities are counted and the name or names of persons handling them recorded, so that an error can be quickly localized in the event a shortage occurs.

Each sheet of security paper received from the division of paper custody of the Treasury Department is charged to the bureau at face value of the security authorized to be printed thereon. Any sheet lost, whether blank or printed, is made good at such face value. Through a system of reports the movement of these securities from one division to another is recorded daily at a central point known as the accounting division, where the responsibility for the securities in a division is fixed as soon as the transfer has been accomplished. A group of auditors from one of the branches of the Treasury Department not connected with the bureau is constantly at work verifying the balances as recorded in the accounting division with the actual securities on hand in the several divisions to determine that securities have not been removed maliciously without detection.

Considering the millions of sheets handled in various stages of manufacture, there are ordinarily very few actual losses which require reimbursement by employees. Misplacements do occur occasionally on account of sheets becoming mixed in the wrong loose packages, but these are readily corrected. None of the employees are bonded, but each feels a personal responsibility concerning his or her work.

All of the sheets must be accounted for in each division before any employee of that division is permitted to leave the building at the close of work. Obviously, on account of the character of the work executed, bureau employees are not permitted to leave the building during the noon lunch period. Due to the strict accounting required in connection with the handling of the large volume of sheets con-

stantly going through the processes of manufacture there is necessarily some lost motion, but only about 30 minutes are lost in checking all work in the proper places at the close of the day. This is a very short period when consideration is given to the fact that there are thousands of employees and millions of sheets of securities and other articles handled daily.

MEDICAL FACILITIES

The health of the employee is a very vital part of the bureau's function; therefore, accidents, occupational diseases, as well as general diseases, must be reduced to a minimum; otherwise plant efficiency would be seriously impeded. Years ago it was definitely determined, upon a small scale, that the permanent maintenance of a medical office would ultimately prove highly remunerative. To-day the bureau is operating a special emergency hospital, provided with separate wards for men and women, under the direct supervision of a full-time physician, assisted by four registered nurses. It is completely equipped with modern medical appliances, and it purchases the best supplies the market affords for the numerous and various cases handled in the course of a year.

The plant is frequently inspected in accordance with hygienic and sanitary requirements of the Public Health Service, and every effort is made to prevent the spread of respiratory and other diseases.

COOPERATIVE LUNCH ASSOCIATION

In a factory such as the bureau the health, comfort, and happiness of its employees are just as essential as that the machinery should be oiled or kept in good condition. In this connection it might not be amiss to add that a man who is well fed is in better condition to render good service than one who is poorly fed and perhaps in need of proper nourishment. With this end in view provisions have been made for a cooperative form of lunch room. The Government furnished the necessary fixtures, kitchen utensils, heat, light, and fuel, while the employees organized into a cooperative society or association, assessing each member a nominal sum as a membership fee to create a fund necessary to commence business, issued a certificate for same, and in the event of the said employee leaving the service, on the surrender of the certificate the amount subscribed was refunded to him. This association, comprising all the employees, elects its officers, who in turn select a manager to conduct the business; purchase the necessary food, hire help, and have the food cooked and served to employees at cost; that is, at such a figure as to maintain the service on a good business basis. It has been determined that by such an arrangement it is possible to give substantial and wholesome food at a much less cost than it could be purchased from a private caterer. Provision has also been made for lunch rooms on the roof of the two center wings, thus permitting the employees to secure fresh air during the lunch period.

STATISTICAL INFORMATION

Some idea of the magnitude of the activities of the bureau may be obtained from the following statistical information: The average number of currency notes delivered yearly is approximately 992,000,000,

or a daily average of 3,360,000. The value of the delivery yearly is \$3,945,000,000, making a daily average of \$13,370,000. The notes delivered daily laid end to end would make a strip 395 miles long, and a year's printing would make four belts around the earth at the Equator. Laid out flat, a year's printing would make a sheet large enough to cover 37 farms of 100 acres each. Laid flat on top of each other the notes printed in a year would make 555 stacks, each as high as the Washington Monument. The weight of the paper used in printing currency amounts yearly to 1,550 tons, or a daily average of $5\frac{1}{4}$ tons. The average cost to produce a note, including the paper, is approximately 0.9 cent.

The average yearly output of postage stamps is 16,000,000,000 stamps, or a daily output of 54,240,000 stamps. The value of this output yearly is \$467,000,000, or \$1,600,000 daily. The weight of the paper used in printing is 1,000 tons yearly, $3\frac{2}{5}$ tons daily. The daily output of stamps, if laid end to end, would make a strip 855 miles long and a year's output would reach 10 times around the earth. The stamps produced in a year, if worked into one piece, would make a patchwork of over 20 colors large enough to cover twenty-two 100-acre farms. If the stamps printed in one year were distributed equally, each man, woman, and child in the United States would receive 160 stamps. The gum used in manufacturing postage stamps is made from dextrine, a form of tapioca starch. If all of the dextrine used in the manufacture of postage stamps in a year were made into a tapioca pudding, it would be sufficient to serve dessert to the entire population of Greater New York for one meal. The cost of producing postage stamps is approximately 1 cent for 125 stamps.

The number of revenue stamps printed yearly is approximately 7,827,000,000, or an average of 27,000,000 stamps a day. The value of the stamps delivered daily is \$1,574,000, or a total of \$464,220,000 a year.

For use in printing the yearly output about 2,700 tons of ink are manufactured in the bureau ink mill from raw materials (dry colors, oils, etc.). If this ink were loaded in box cars of average capacity, it would fill 90 cars and make two trains each 2,250 feet long.

THE DIFFERENT CLASSES OF PAPER CURRENCY

Only five of the seven classes of paper currency in circulation in the United States are now being printed and issued. These five classes are: United States notes, gold certificates, silver certificates, Federal reserve notes, and national bank notes. Treasury notes of 1890 and Federal reserve bank notes, which are outstanding at the present time in small amounts, are being retired and canceled as rapidly as presented for redemption.

United States notes.—United States notes are often referred to as "greenbacks" or "legal tenders." These notes were originally issued under authority of the acts of February 25 and July 11, 1862, and March 3, 1863. The highest amount outstanding at any time was \$449,338,902 on January 30, 1864. This amount was gradually reduced until the act of May 31, 1878, which required the notes to be reissued when redeemed. Since that time the amount outstanding has remained \$346,681,016.

United States notes are protected by a gold reserve of approximately \$156,000,000 held in the Treasury. They are full legal tender for all debts, public and private, except duties on imports and interest on the public debt. Since the resumption of specie payments on January 1, 1879, however, these notes have been freely accepted on all accounts. They are redeemable in gold coin and will be received for redemption by the Treasurer of the United States or any Federal reserve bank or branch. United States notes may be issued in any denomination not less than \$1. At the present time these notes are issued in denominations of \$2 and \$5 only, though notes of other denominations are outstanding and in circulation.

Gold certificates.—Gold certificates are issued against deposits of not less than \$20 in gold coin with the Treasurer of the United States or with the Federal reserve banks and their branches, deposits of gold bullion or foreign gold coin in sums not less than \$1,000 with the mints and assay offices, or against available gold in the general fund of the Treasury. Gold certificates may be obtained in payment of obligations of the United States payable in gold, in payment of checks by the mints and assay offices of the United States for deposits of gold bullion and foreign gold coin, in exchange for other forms of United States paper currency, or in the ordinary course of Government payments when paid out by the Treasurer or the Federal reserve banks. These certificates, payable to bearer on demand, are legal tender in payment of all debts and dues, public and private, and will be received by the Treasurer of the United States or by any Federal reserve bank for redemption in gold.

Gold certificates may be issued in any denomination not less than \$10. The following denominations are now issued: \$10, \$20, \$50, \$100, \$500, \$1,000, \$5,000, and \$10,000.

Silver certificates.—Silver certificates are issued against deposits of standard silver dollars or available silver dollars in the general fund of the Treasury, and may be obtained in exchange for other forms of United States paper currency or in the ordinary course of Government payments when available. These certificates are redeemable only in standard silver dollars and may be presented for redemption to the Treasurer of the United States or to any Federal reserve bank or branch. They are not legal tender but are receivable in payment of all public dues and when so received may be reissued. They may be held as lawful reserve by Federal reserve banks.

Silver certificates may be issued in the following denominations: \$1, \$2, \$5, \$10, \$20, \$50, and \$100. At the present time new issues of silver certificates are restricted to the lower denominations.

Federal reserve notes.—The Federal reserve act, approved December 23, 1913, established the Federal reserve system and provided for an elastic currency in the form of Federal reserve notes. Federal reserve notes are issued at the discretion of the Federal Reserve Board, through the Federal reserve agents, for the purpose of making advances to Federal reserve banks to supply currency requirements. Any Federal reserve bank requiring additional notes makes application therefor to its Federal reserve agent, who is a representative of the Federal Reserve Board. Such application must be accompanied by a tender of collateral in amount equal to the sum of the Federal reserve notes applied for. This collateral may consist of

gold or gold certificates, or paper which has been discounted or purchased in the open market by the Federal reserve banks and which meets certain other requirements as set forth in the Federal reserve act. Each Federal reserve bank is required to maintain a reserve in gold of not less than 40 per cent against its Federal reserve notes in actual circulation. The gold-redemption fund maintained on deposit in the Treasury of the United States, which must be not less than 5 per cent of the Federal reserve notes issued less the amount of gold and gold certificates held by the Federal reserve agent as collateral security, may be counted as a part of the required 40 per cent reserve.

Federal reserve notes are obligations of the United States and are receivable on all accounts by all Federal reserve banks, national banks, and other member banks. They are also receivable for all taxes, customs, and other public dues. They are redeemable in gold on demand at the Treasury Department in Washington, or in gold or lawful money at any Federal reserve bank.

Federal reserve notes are issued in the following authorized denominations: \$5, \$10, \$20, \$50, \$100, \$500, \$1,000, \$5,000, and \$10,000.

National-bank notes.—Any national bank may issue national-bank notes upon the deposit of certain prescribed United States bonds bearing the circulation privilege in trust with the Treasurer of the United States. The amount issued may not exceed the par value of the bonds so deposited, nor the amount of the capital stock of the issuing bank actually paid in. Each bank is required to maintain upon deposit at all times with the Treasurer of the United States lawful money equal to 5 per cent of its note circulation, the fund to be held and used for redemption purposes. National-bank notes are obligations of the issuing bank. They are not legal tender, but are receivable for all public dues, except duties on imports, and may be paid out by the Government for all purposes except interest on the public debt and for redemption of the national currency. They are redeemable on demand in lawful money of the United States by the Treasurer of the United States and by the issuing bank. Payments in lawful money on account of redemption may also be effected through the Federal reserve banks and branches.

National-bank notes are authorized to be issued in denominations of \$1, \$2, \$5, \$10, \$20, \$50, \$100, \$500, and \$1,000. At the present time these notes are issued only in denominations of \$5, \$10, \$20, \$50, and \$100.

There are many ways in which money gets into circulation. The holder of gold bullion or foreign gold coin, for example, may deposit the same at a mint and receive therefor coin equal in value to the bullion deposited, or he may exchange his gold for gold certificates or other forms of currency. Money may also get into circulation through the payment by the Government of its obligations in cash. Exchanges of old money for new and of one kind for another are also going on constantly; e. g., silver certificates issued in exchange for silver dollars, or subsidiary silver and minor coins issued in exchange for other forms of money. National banks and Federal reserve banks put their notes into circulation either by paying them out to depositors and bona fide holders of checks in due course, or through the proceeds of loans granted by these banks.

WHAT HAPPENS TO PAPER CURRENCY AFTER IT LEAVES THE BUREAU

The bureau delivers the finished currency to three different places, depending upon the class of currency. United States notes and gold and silver certificates are delivered to the reserve vaults of the Treasurer of the United States, and national-bank notes to the reserve vaults of the Comptroller of the Currency, both in the Treasury Department Building. Federal reserve notes are delivered to the Federal reserve vault located in the Bureau of Engraving and Printing Building. The Treasurer of the United States ships the United States notes and gold and silver certificates to the Federal reserve banks and their branches; the Comptroller of the Currency ships national-bank notes to national banks; and the Bureau of Engraving and Printing ships Federal reserve notes to Federal reserve banks and their branches on orders from the Comptroller of the Currency. The Federal reserve banks and their branches make shipments of currency to their member and other banks. The greater portion of the new currency printed each year is received by the public from the commercial banks of the country.

All currency delivered by the Bureau of Engraving and Printing is transported in bullet-proof, armored trucks, under the protection of armed guards.

After notes have been placed in circulation by the banks, what vicissitudes they pass through until they are unfit for further use can only be imagined. The unfit notes are withdrawn from circulation by the banking institutions of the country and are forwarded to the Federal reserve banks and branches, who, in turn, forward them to the Treasurer of the United States at Washington, who makes settlement therefor with new notes or by credit. United States notes and gold and silver certificates, national-bank notes, and Federal reserve notes, unfit for further circulation, finally reach the Treasury Department, where the currency is counted and scheduled to the destruction committee, under whose supervision it is macerated into pulp in the macerators located either in the Treasury Building or in one of the buildings of the Bureau of Engraving and Printing. Approximately 6,000,000 pounds of wet pulp are obtained annually from these macerations, which is sold to the highest bidder on an annual contract. The statutes require that all paper currency when replaced according to law or when taken up and reissued shall be destroyed either by burning to ashes or by maceration and the pulp from such macerations shall be disposed of under the direction of the Secretary of the Treasury.

ORGANIZATION

The Bureau of Engraving and Printing is a bureau of the Treasury Department, and consequently is under the jurisdiction of the Secretary of the Treasury. The work of the bureau is under the immediate jurisdiction of the director, who is appointed by the Secretary through civil service.

The activities of the bureau are divided into two groups, each under the jurisdiction of an assistant director. One group is designated "Administration" and the other "Production." Each group is divided into operating divisions, and each division headed by a

superintendent. The divisions are subdivided into sections, and each section headed by either a foreman or forewoman. Many of the large sections are subdivided into units headed by supervisors.

Number of employees of the Bureau of Engraving and Printing as of December 31, 1928

Division or office:	Number of employees
Office of the director	5
	5
Administration group:	
Accounting division	44
Disbursing division	4
Personnel division	12
Purchase, storage, and issue division	26
Mail and files division	13
Federal reserve vault	7
Plate vault	11
Buildings and grounds division	365
Watch division	104
Hygienic division	5
Engineering and machine division	313
Orders division	10
Press-register division	20
Garage division	28
Total	962
Production group:	
Wetting division	158
Plate-printing division	1,331
Numbering division	357
Postage-stamp division	224
Surface-printing division	513
Laboratory and ink mill	35
Engraving division	198
Examining division	869
Total	3,685
Office of the mechanical expert and designer	2
Total	4,654

Statement showing volume of work delivered, expenditures, and number of employees since 1878 (every fifth fiscal year shown)

Year	Number of sheets delivered	Expenditures	Number of employees	Year	Number of sheets delivered	Expenditures	Number of employees
1878-----	13,098,756	\$538,861.33	522	1908-----	210,589,197	\$3,841,173.60	3,572
1883-----	33,330,746	1,104,986.43	1,173	1913-----	287,192,192	4,449,726.22	3,920
1888-----	38,040,984	948,995.83	895	1918-----	396,790,285	9,086,303.90	6,214
1893-----	48,853,528	1,228,464.36	1,333	1923-----	411,546,429	10,106,320.28	5,536
1898-----	92,979,478	1,570,508.46	1,623	1928-----	483,455,932	9,734,906.41	4,979
1903-----	155,743,601	3,136,477.73	2,850				

Executive officers of the Bureau of Engraving and Printing from the date of its establishment to the present time

No.	Name	Title	Date of appointment
1	S. M. Clark	Chief	Aug. 22, 1862
2	George B. McCartee	do	Mar. 18, 1869
3	Henry C. Jewell	do	Feb. 21, 1876
4	Edward McPherson	do	May 1, 1877
5	O. H. Irish	do	Oct. 1, 1878
6	Thomas J. Sullivan	Acting chief	Jan. 28, 1883
7	Truman N. Burrill	Chief	Apr. 1, 1883
8	Edward O. Graves	Acting chief	May 20, 1885
9	do	Chief	June 1, 1885
10	William M. Meredith	do	July 1, 1889
11	Claude M. Johnson	do	July 1, 1893
12	do	Director	July 1, 1896
13	Thomas J. Sullivan	Acting director	May 11, 1900
14	William M. Meredith	Director	Nov. 24, 1900
15	Thomas J. Sullivan	do	July 1, 1906
16	Joseph E. Ralph	do	May 11, 1908
17	Frank E. Ferguson	Acting director	Oct. 15, 1917
18	James L. Wilmett	Director	Dec. 10, 1917
19	Louis A. Hill	do	Apr. 1, 1922
20	Paul E. Twyman	Acting director	Feb. 15, 1924
21	Wallace W. Kirby	Director	June 15, 1924
22	Paul E. Twyman	Acting director	Dec. 16, 1924
23	Alvin W. Hall	Director	Dec. 22, 1924

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